Combining hydrological modeling and remote sensing observations to enable data-driven decision making for Devils Lake flood mitigation in a changing climate

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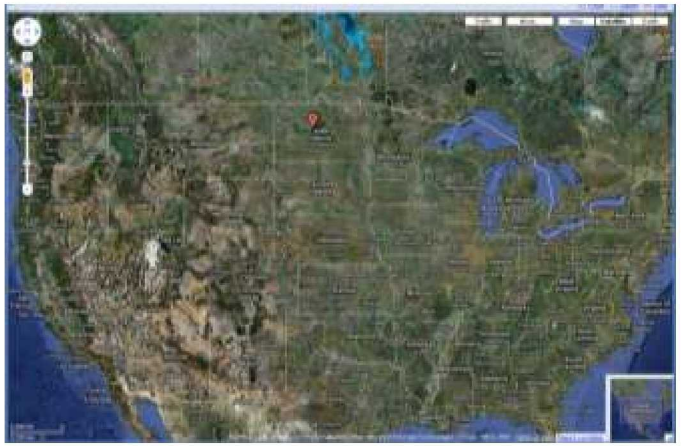
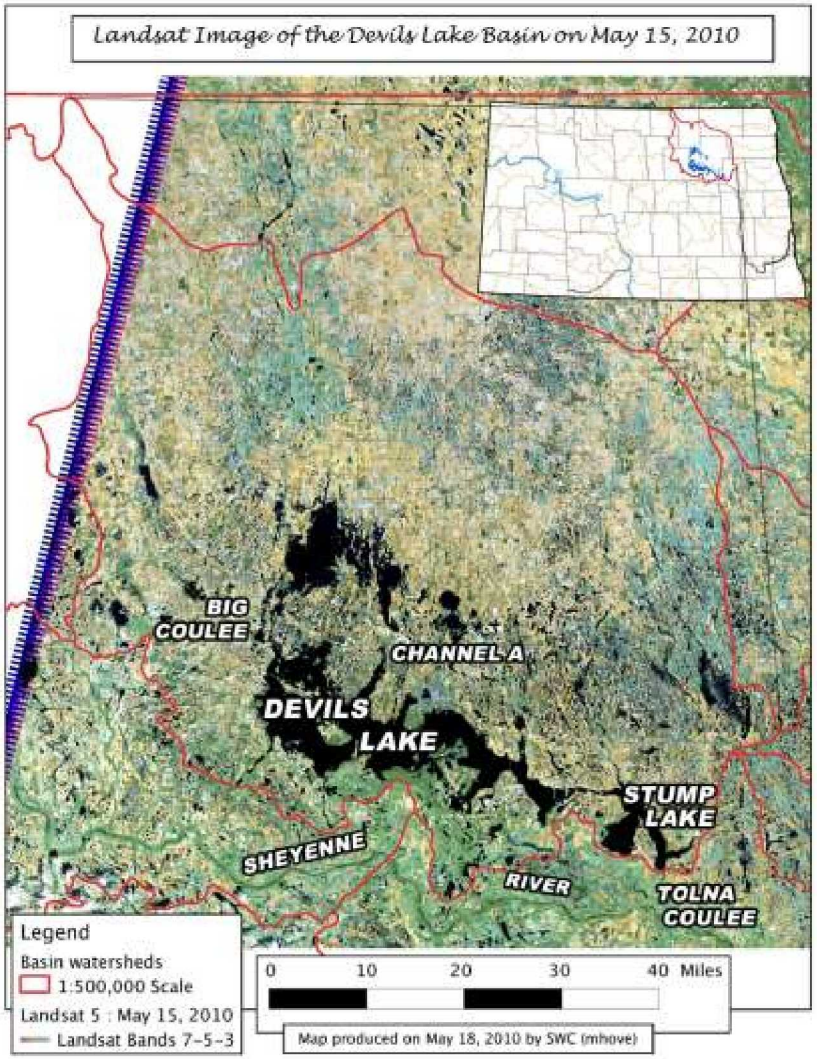
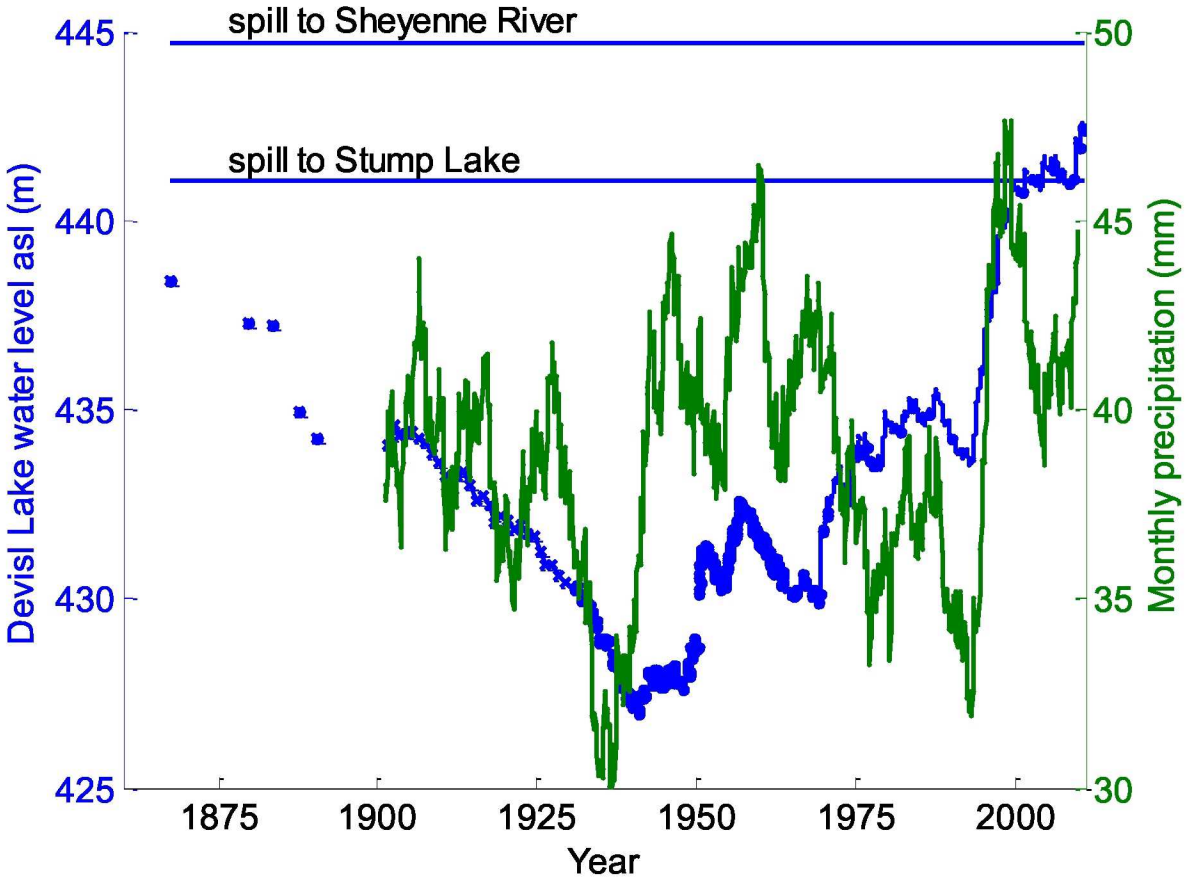
Devils Lake

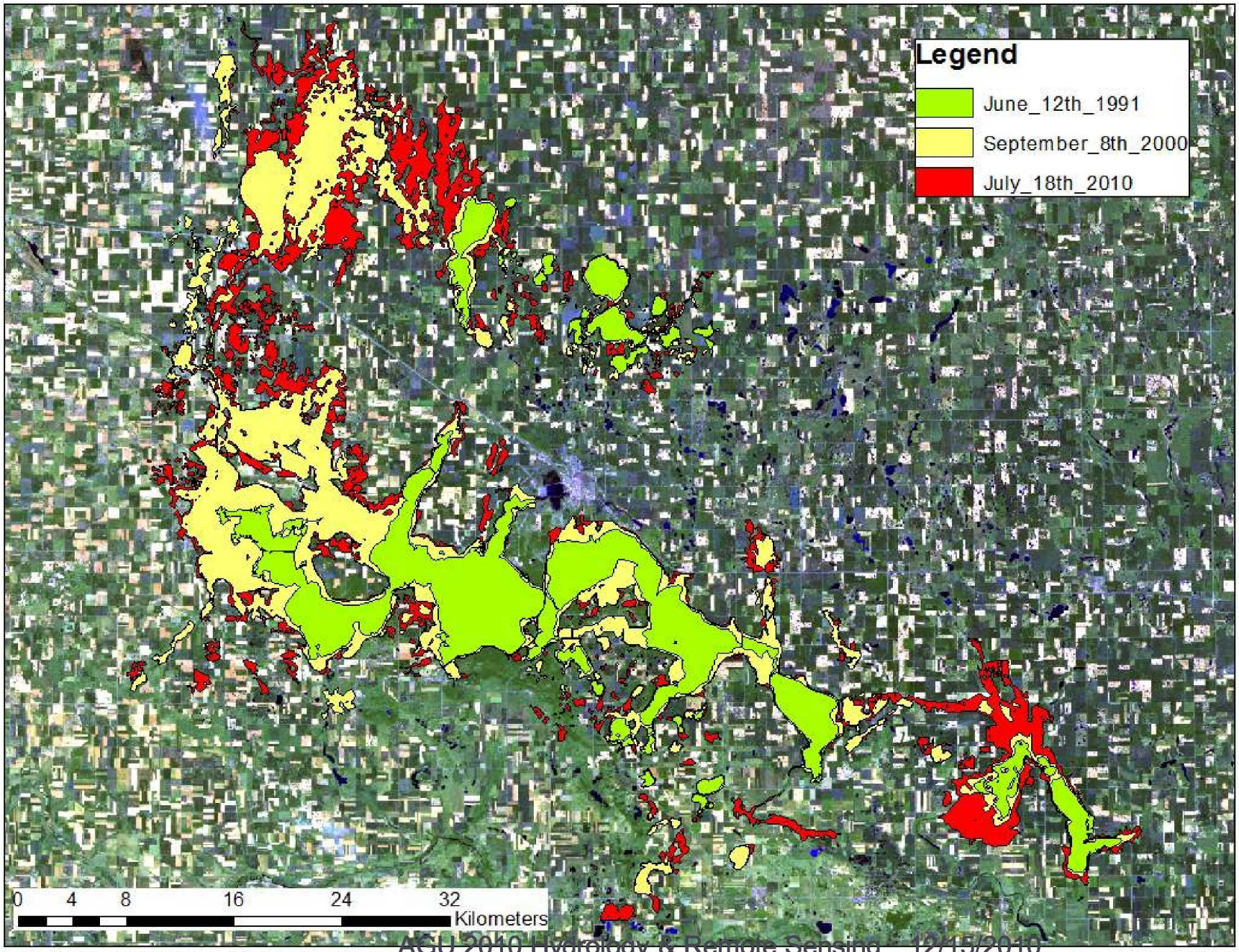


- Northeastern North Dakota
- Terminal lake of nearly 10,000 km^2 (3,800 mi^2) drainage basin

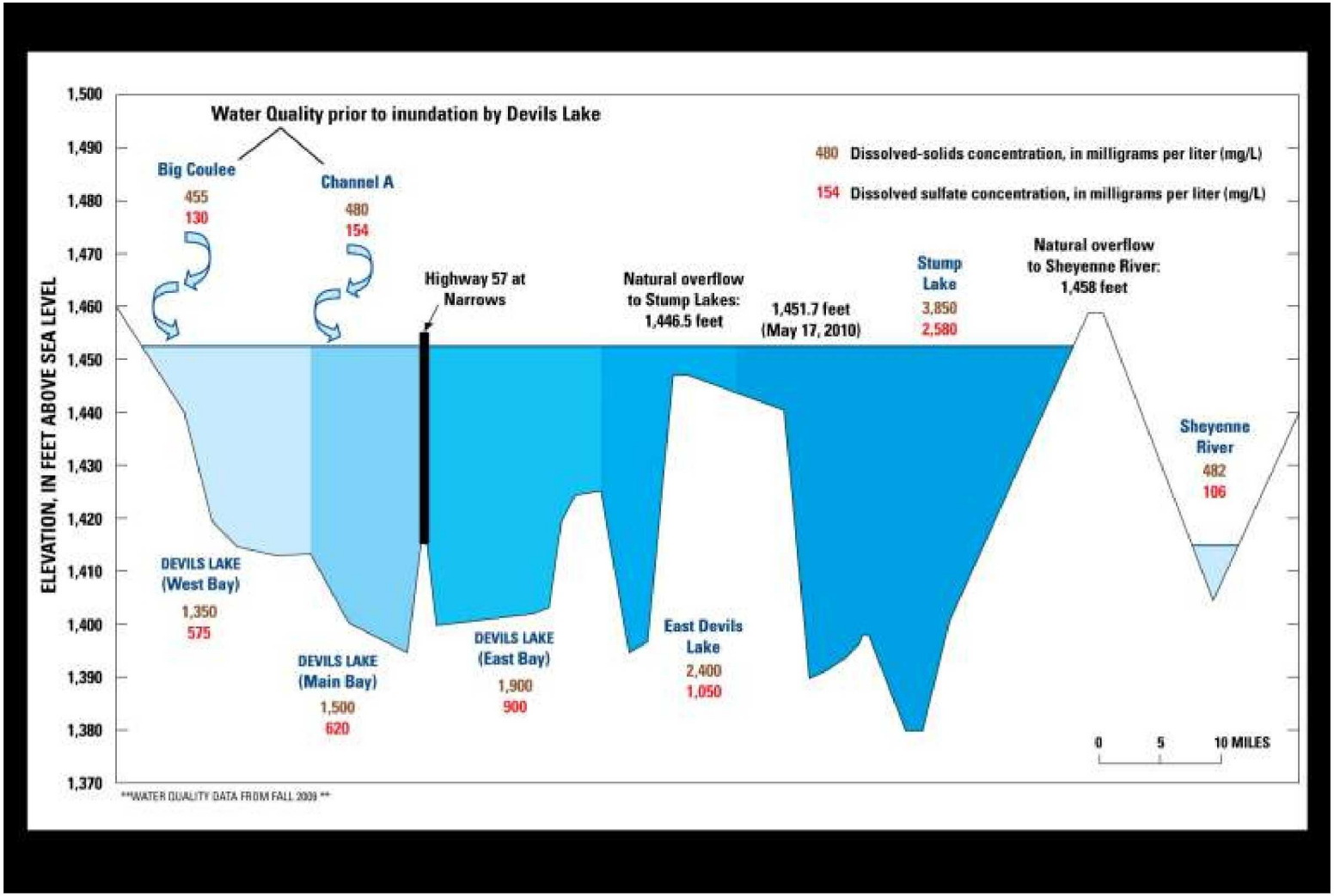


Rising water: $1 billion in flood mitigation

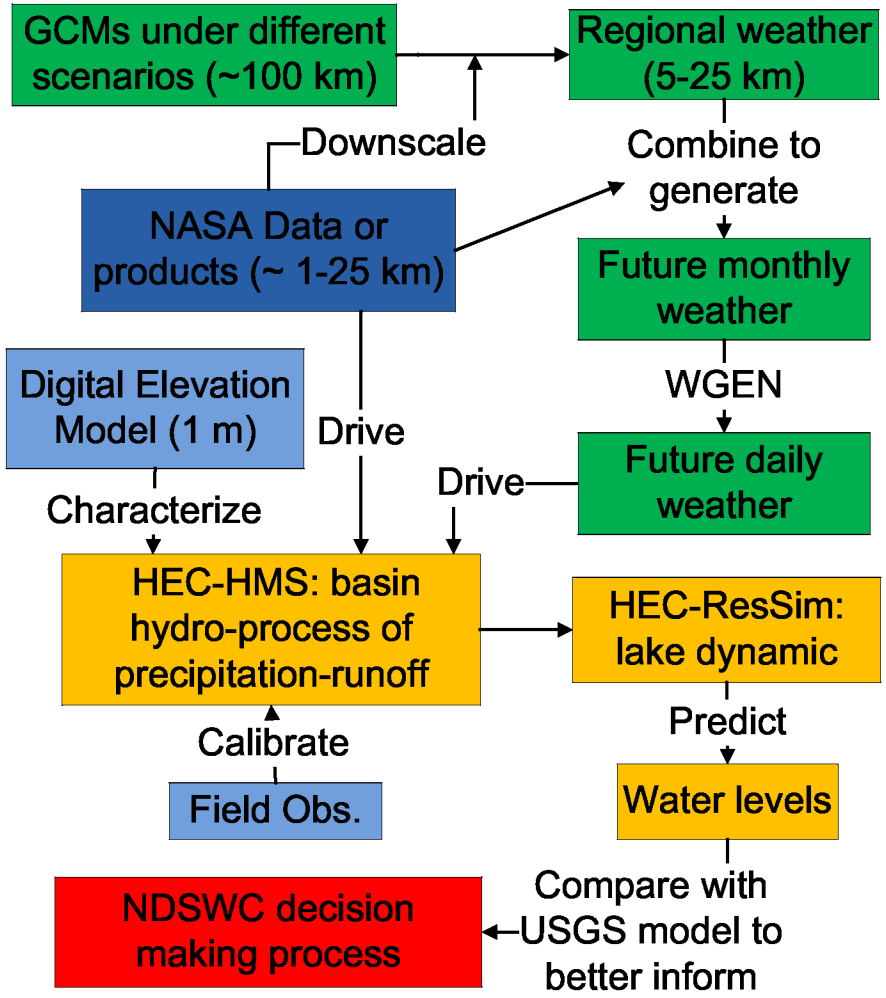



Legend
June_12th_1991
September_8th_2000
July_18th_2010
0
4
8
16
24
32
Kilometers

Poor water quality: environmental concern



Combine satellite observations, hydrological model and climate change



Stakeholders:

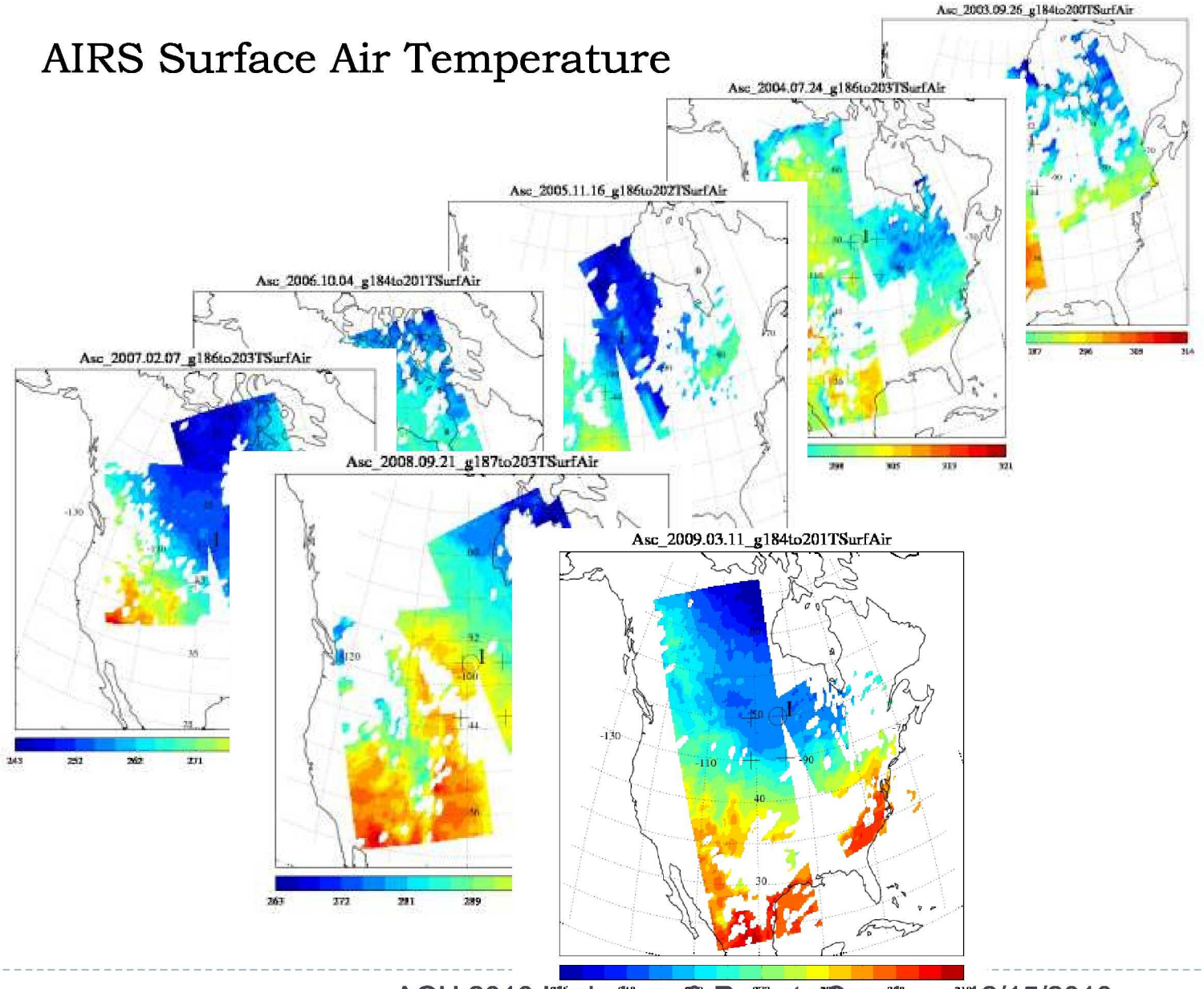
- The Devils Lake Basin Joint Water Resource Board
- North Dakota State Water Commission (NDSWC)
- The People to Save the Sheyenne River

Satellite data products

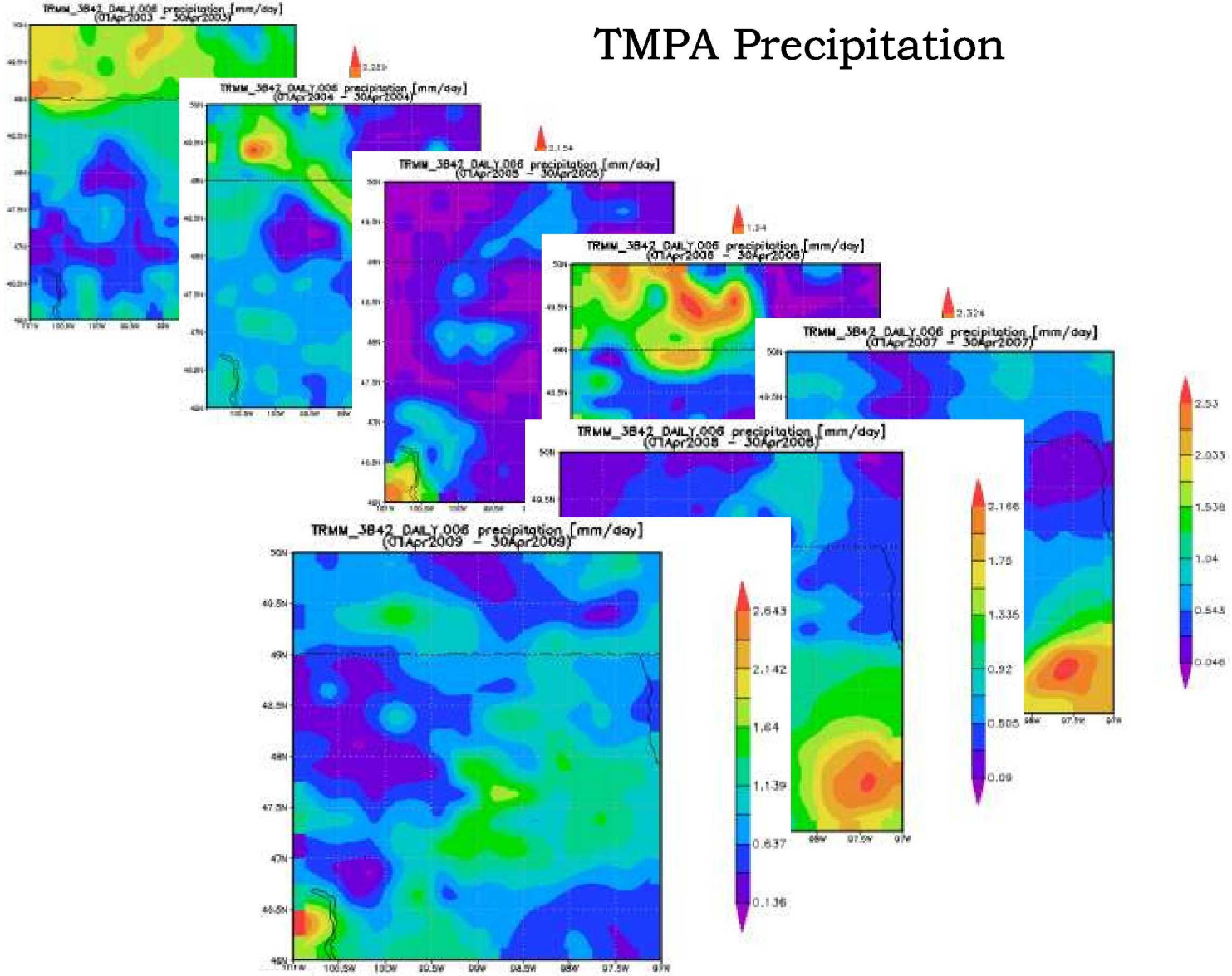
Instrument/Parameter	Spatial Resolution	Spatial Coverage	Temporal Resolution	Temporal Coverage
Aqua AMSR-E Soil Moisture	25 km	Global	Daily	2002-Present
TMPA Precipitation	¼ deg	Global 50N-50S	Daily	1998-Present
Aqua AIRS Surface Air Temperature	45 km	Global	Instantaneous day & night	2002-Present

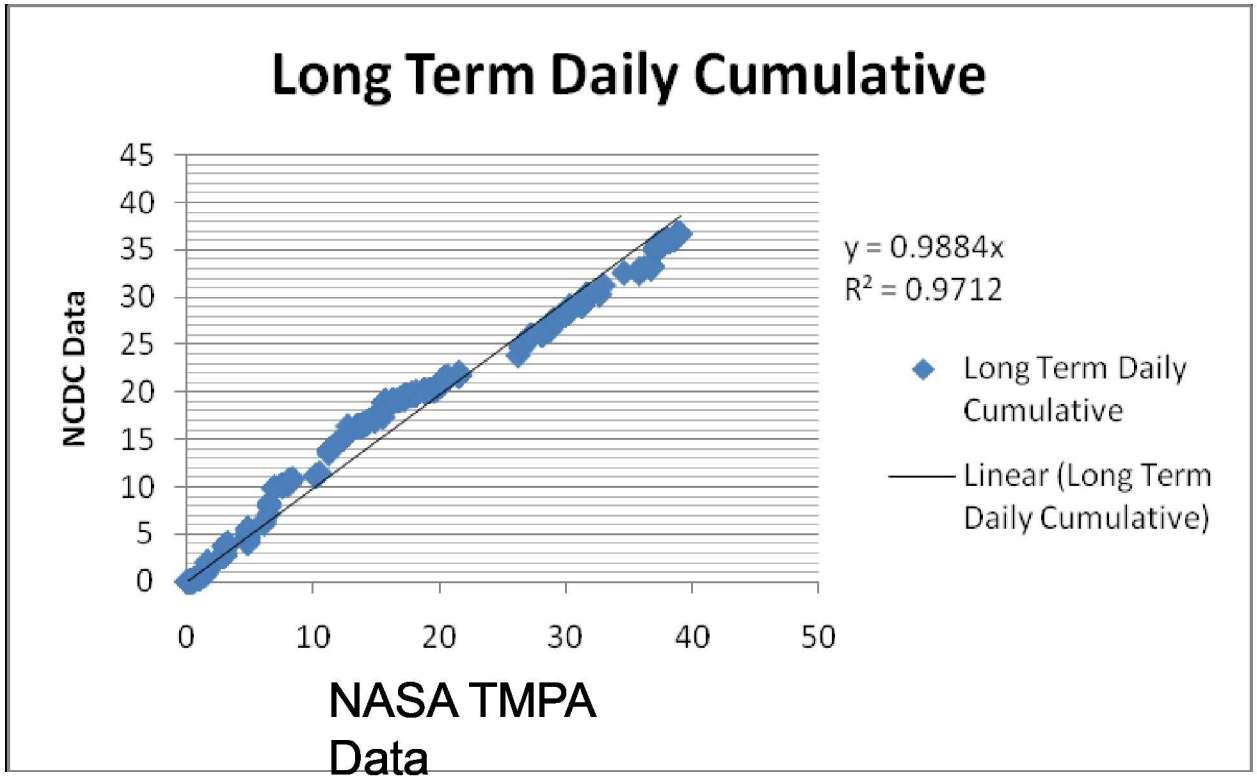
TMPA: TRMM Multisatellite Precipitation Analysis

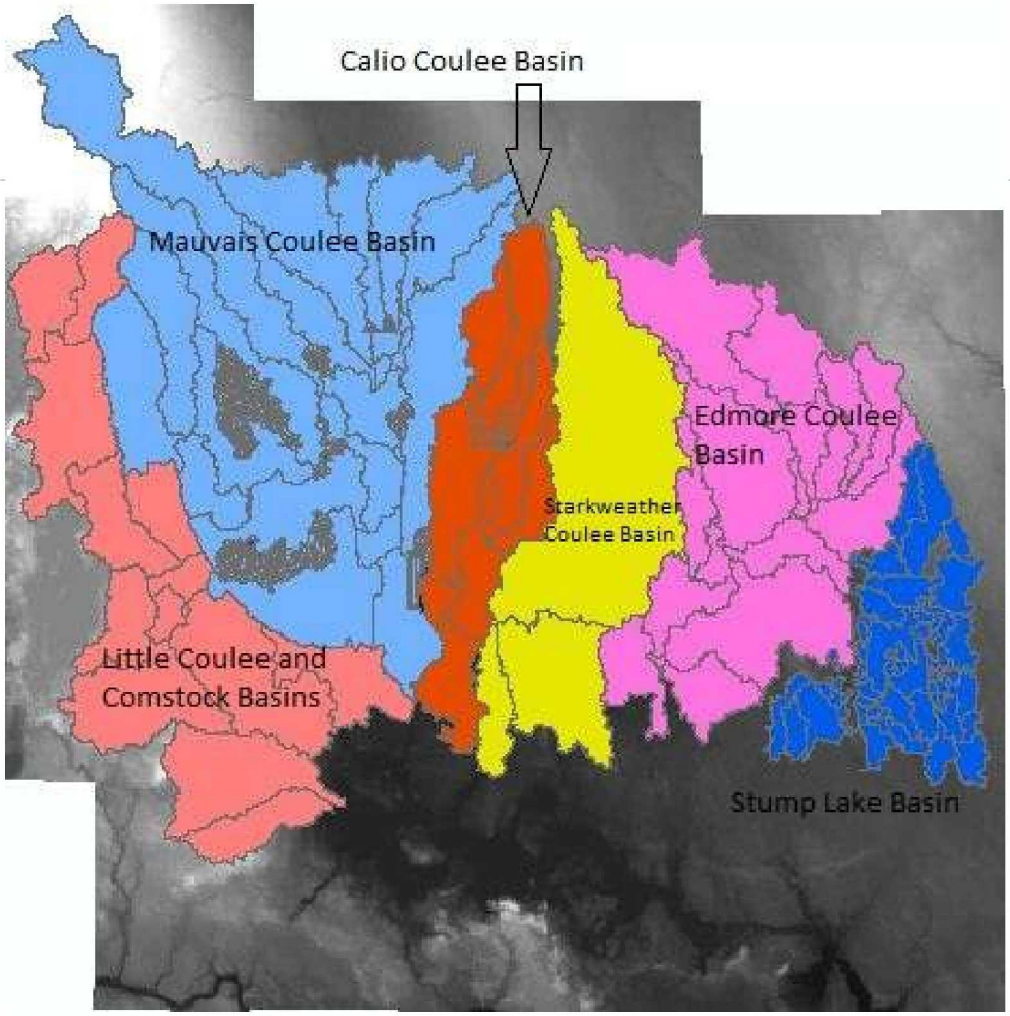
AIRS Surface Air Temperature



TMPA Precipitation

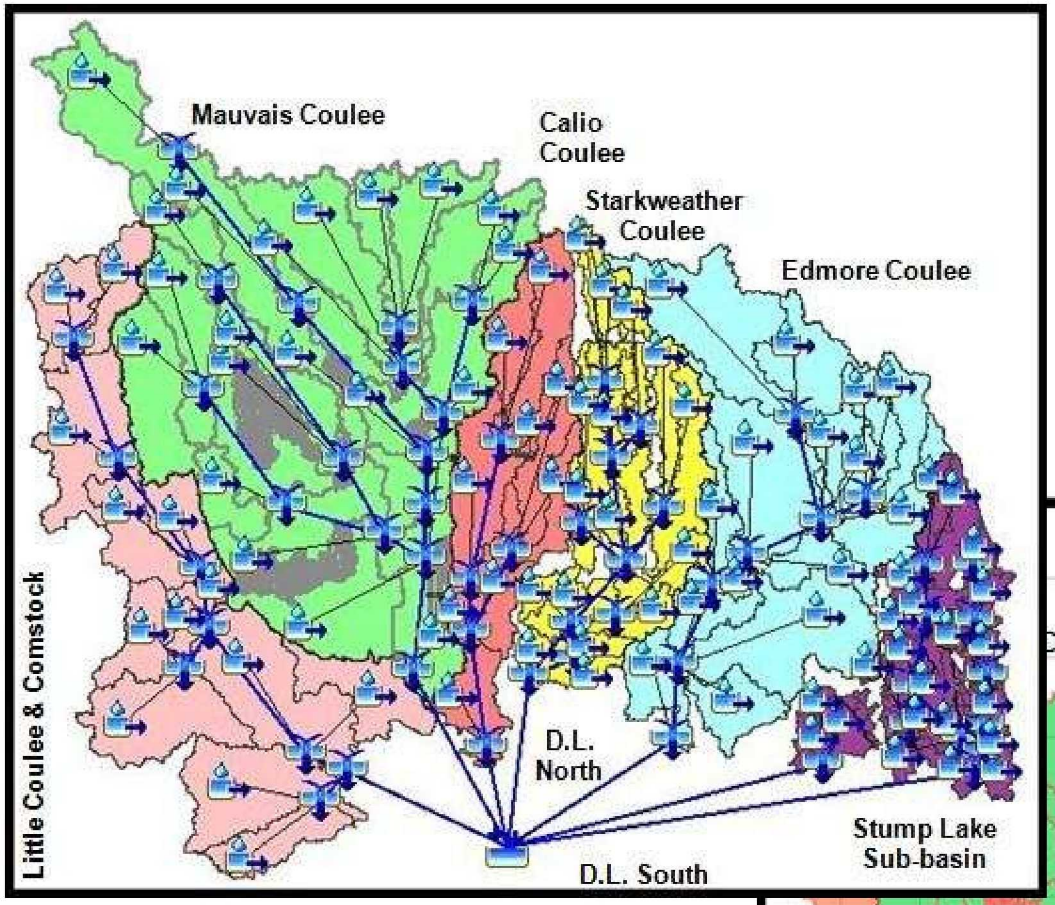



Long Term Daily Cumulative
NCDC Data
45
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
NASA TMPA Data
y = 0.9884x
R² = 0.9712
Long Term Daily Cumulative
Linear (Long Term Daily Cumulative)

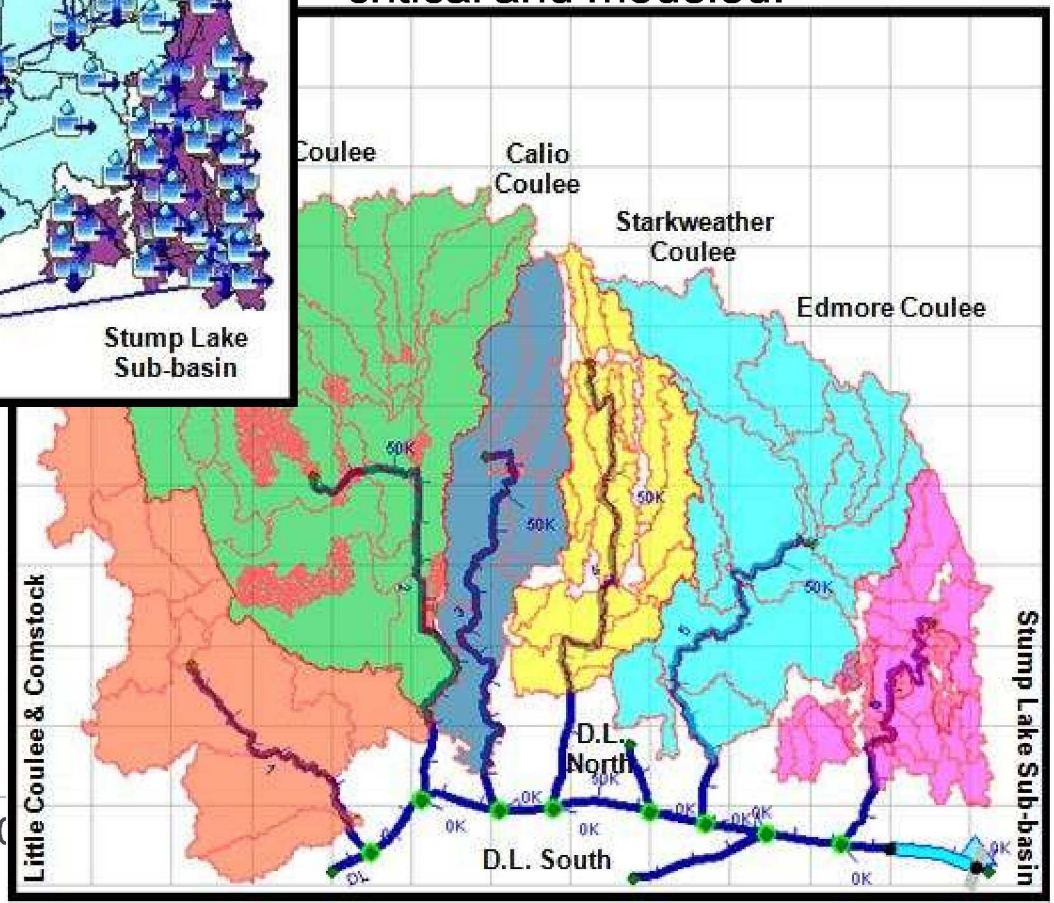


DEM of Devils Lake Watershed

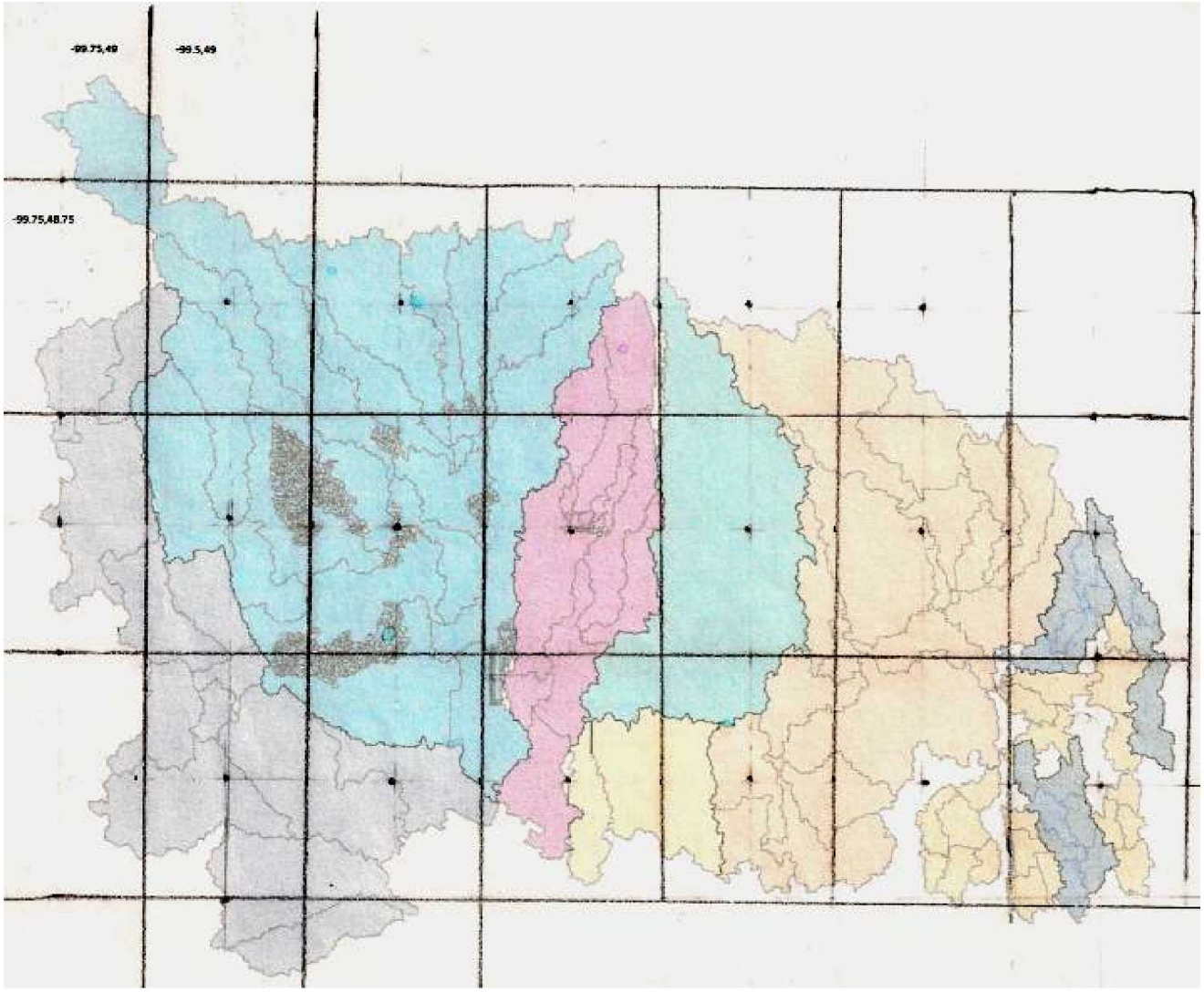
There are 6 major basins delineated using Arc-Hydro



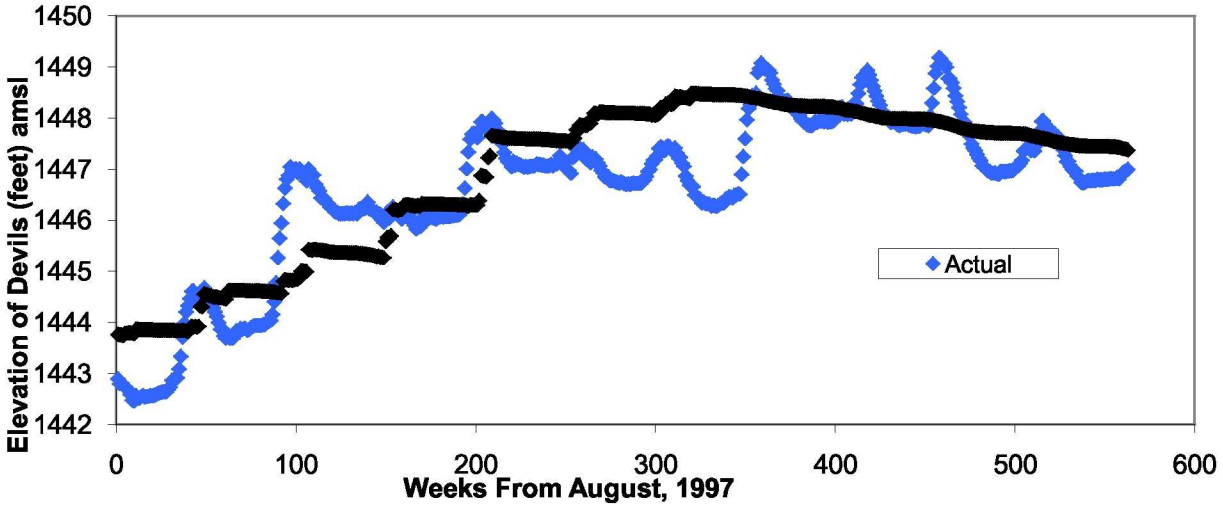
HEC-HMS modeling for each basin. For example, there are 20 sub-basins for Mauvais Coulee Basin. Main parameters: channel lengths , lags, slopes, and routing parameters. Snow melting is critical and modeled.

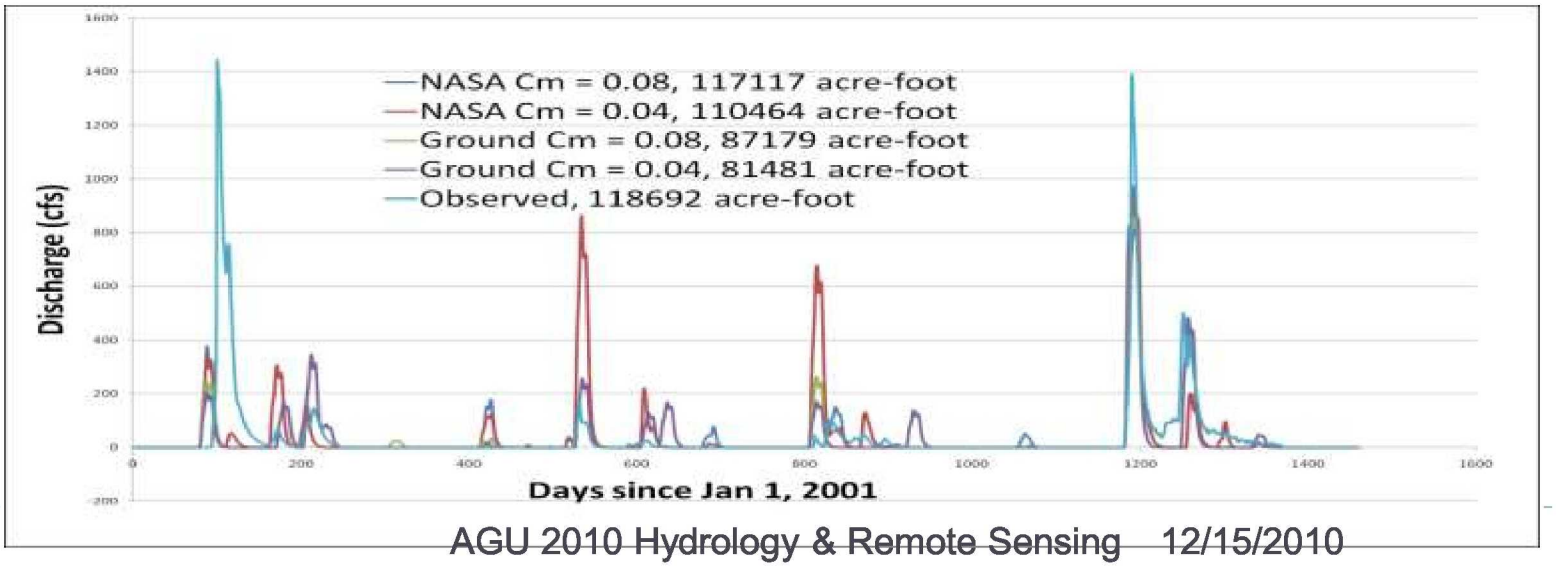


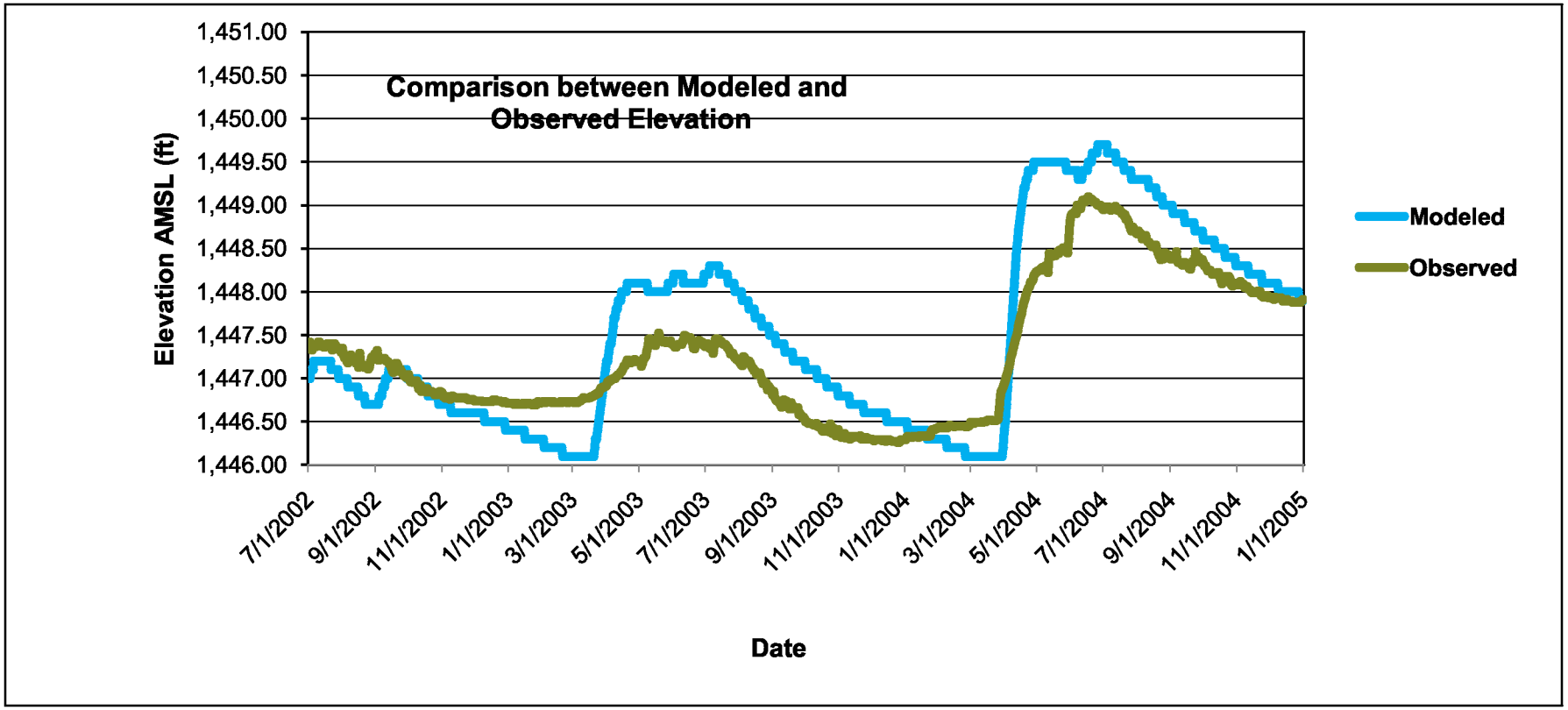
HEC-ResSim model: inflows from basins, precipitation, pumping schedule, evaporation, seepage rate, and eventual spill rate.


-99.75,49
-99.5,49
-99.75,48.75

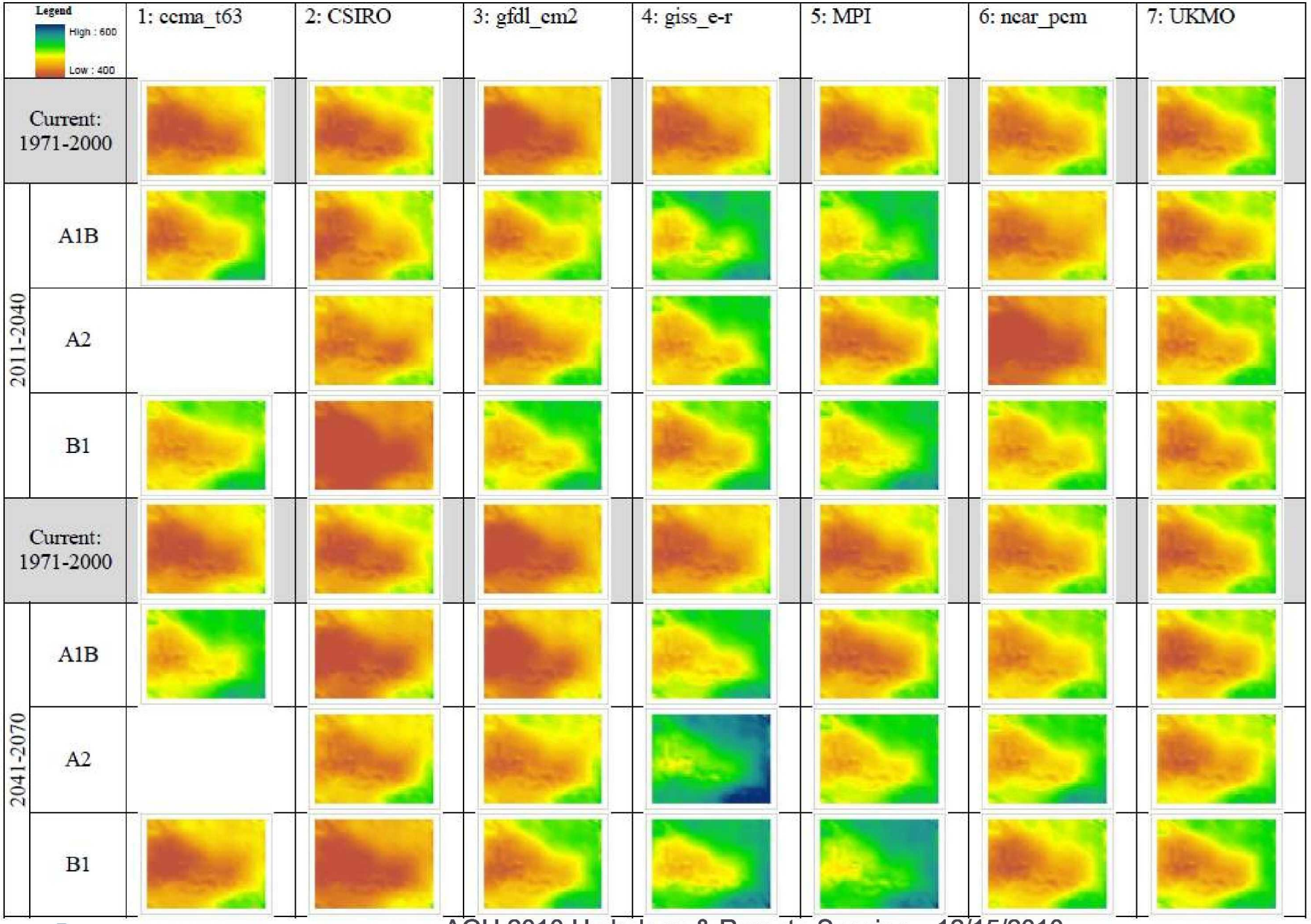
Advantages of the use of satellite data and distributed hydrological model



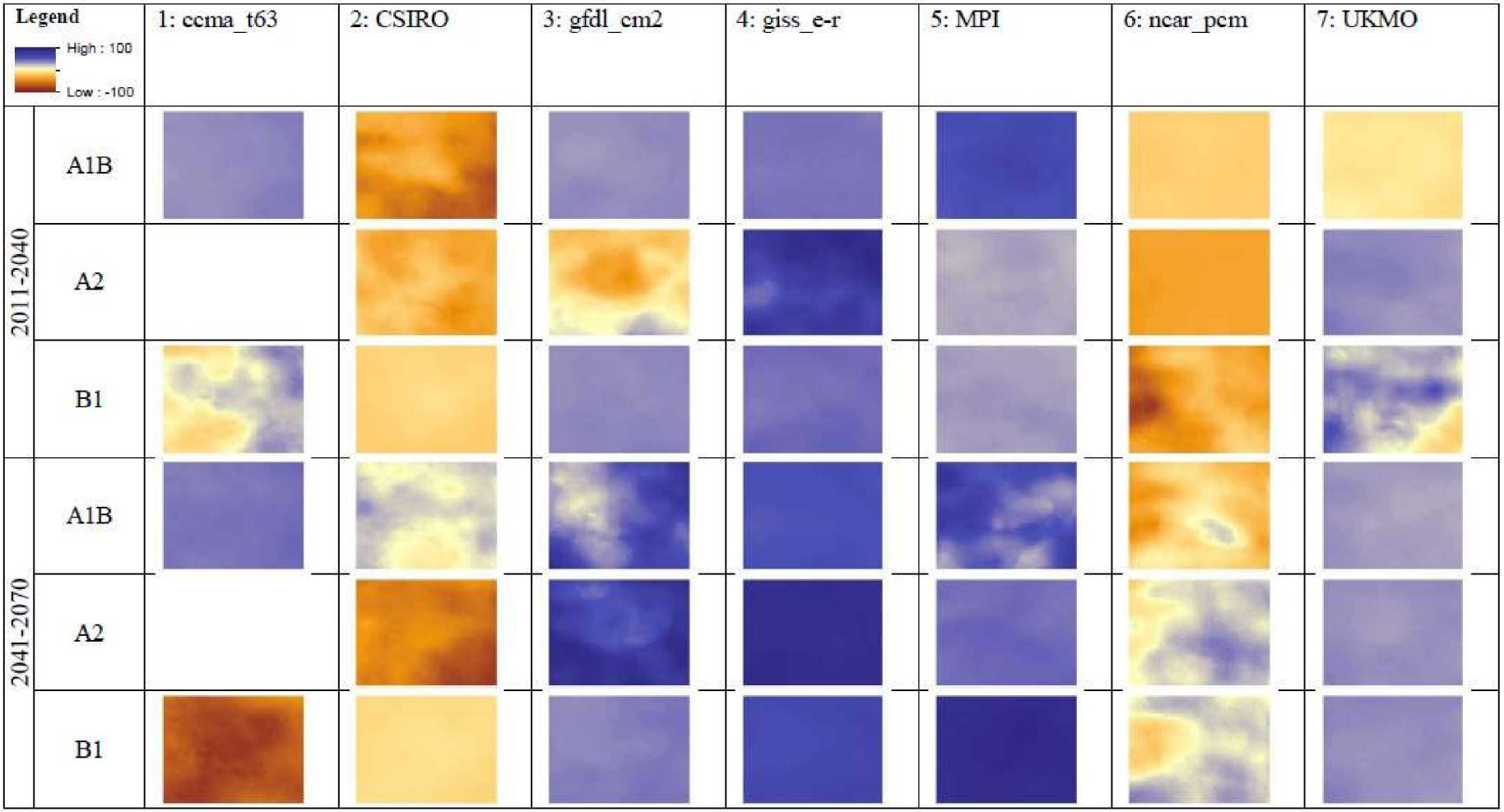




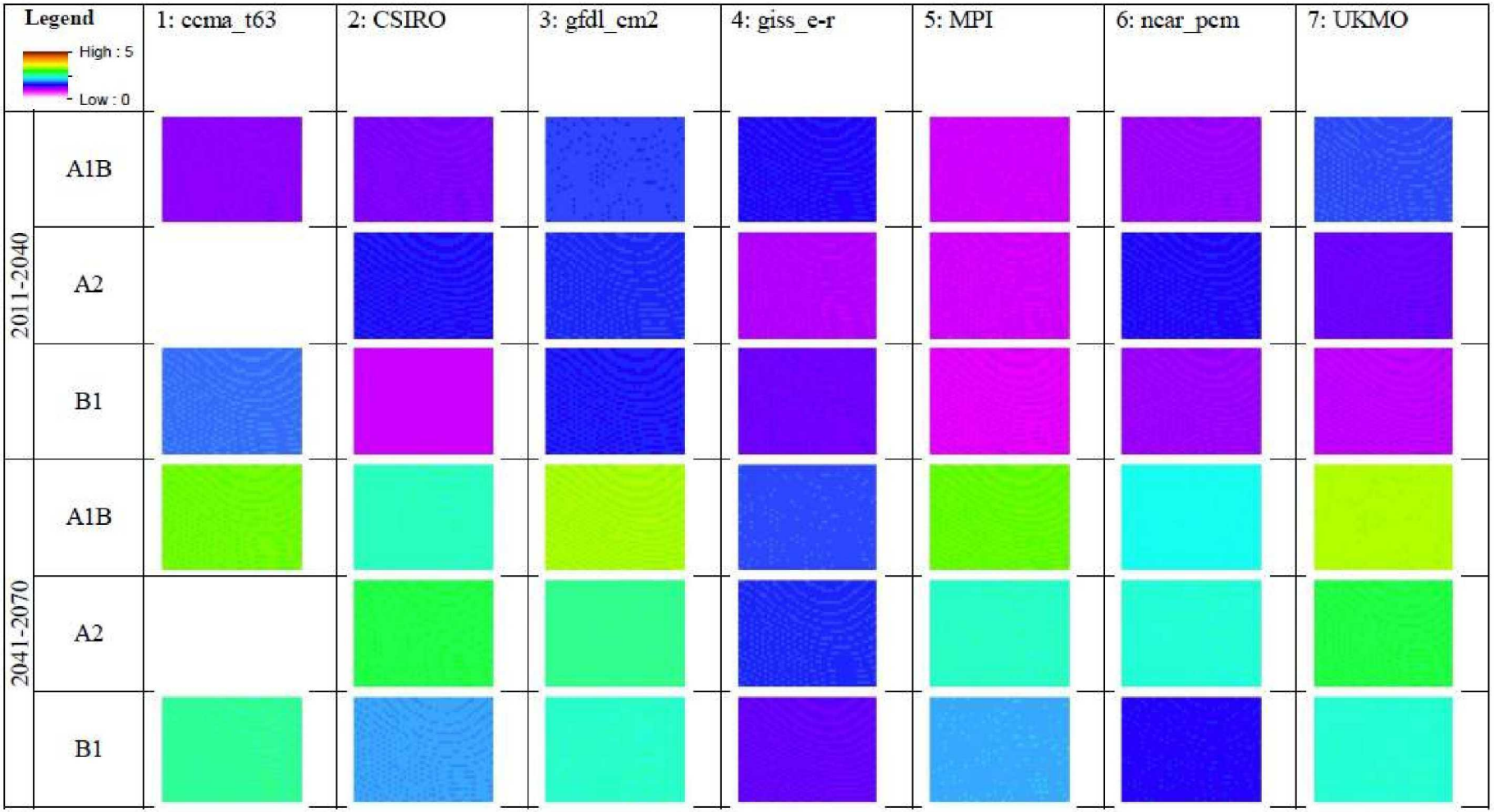
The difference might be due to uncertainty in modeling the seasonal lake evaporation


Legend
High : 600
Low : 400
1: ccma_t63
2: CSIRO
3: gfdl_cm2
4: giss_e-r
5: MPI
6: ncar_pcm
7: UKMO
Current: 1971-2000
2011-2040
A1B
A2
B1
Current: 1971-2000
2041-2070
A1B
A2
B1

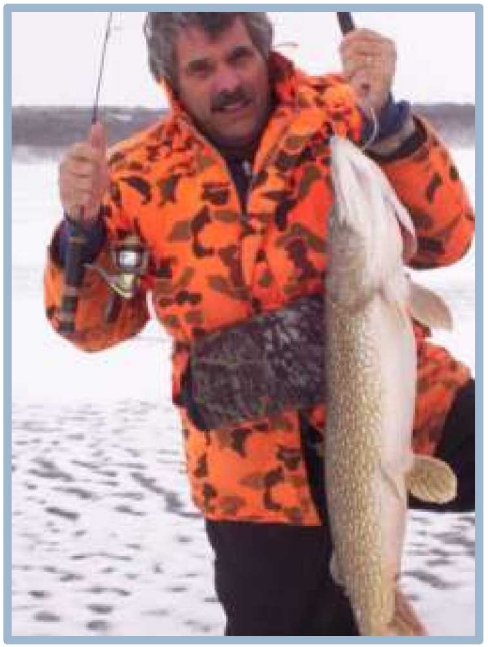
Differential precipitations predicted by different GCMs under different scenarios



Increases of temperature predicted by different GCMs under different scenarios



A bright side of flooding



The shallow, extensive shoreline of the lake provides habitat for walleye, perch, and northern pike